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METHODOLOGY FOR CONSTRUCTION OF PRICE AND QUANTITY INDICES

Study of Trends in Physicians' Fees

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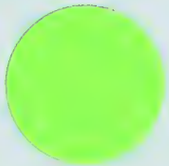

Pennsylvania
Blue Shield

METHODOLOGY FOR CONSTRUCTION OF PRICE AND QUANTITY INDICES

Study of Trends in Physicians' Fees

Research Report R-425-1

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TABLE OF CONTENTS

	Page
I. INTRODUCTION	1
II. THE INDEX MODEL	3
A. Index Formula	4
B. Sample Stratification	5
C. Proportional Weighting of Strata	6
D. Definition of Sampling Units	6
E. Selection of Sample	7
III. DATA BASE ORGANIZATION	9
A. Data Collection	9
B. Index Time Periods	10
C. Selection of Incurred Date Basis	11
D. Determination of Sampling Strata	12
IV. OUTPUT REPORTS	14
APPENDIX A: Index Formulas	16
APPENDIX B: Geographic Index Regions	19
APPENDIX C: Major Index Specialties	21
APPENDIX D: Major Index Types of Service	22

I. INTRODUCTION

The basic purpose and intent of this project is to measure and analyze changes in the price and utilization of physicians' services in selected parts of the United States since 1974; and thence to conduct a series of economic analyses employing these price and utilization data. Specifically, the study is to accomplish the following objectives:

(1) Develop a computer-based physician fee and utilization index model capable of generating structural detail by locality, physician specialty, and generic type of service.

(2) Using physician fee and utilization source data from Medicare and private claims experience files of four Blue Shield Plans (representing the states of Colorado, New Hampshire, Pennsylvania, South Carolina, and Vermont), generate longitudinal and cross-sectional indices describing trends and patterns in physicians' prices and in quantities of services delivered.

(3) Based on analysis of the above claim data and indices, develop an improved understanding of some of the factors related to price dynamics and related issues in the market for physicians' services.

This report focuses on the methodology and rationale for the development of the index model employed to accomplish these objectives. Technical aspects are addressed, such as the specification of the index model, organization of the data by time frames and lines of business, sampling structures, and formulas used in weighting and aggregating indices at various levels. Subsequent studies and analyses using various forms of multivariate analysis

are anticipated in connection with the third objective stated above. These will be discussed in separate reports to be published later.

II. THE INDEX MODEL

The basic model employed in this study is a straightforward, multiplicative form expressing total physician revenues as the product of three main factors: price (the amount charged for each service), utilization rate (the number of services used per person), and population base. These terms may be expressed in their normal units (i.e., fees, incidence rates, and persons at risk), or in terms of indices, in which case the model becomes a vehicle for the analysis of changes over time.

This model is used to analyze the composition of both consumer expenditures and physicians' revenues from third-party insurers. Expenditures may be interpreted as physicians' total incomes from all sources, independent of restrictions imposed by insurers on prices, covered benefits, and eligible persons. Therefore, when analyzed in relation to expenditures, price refers to the average amount billed by the physician for his services, exclusive of Medicare or private Blue Shield reasonability screens. Third-party revenues (referred to henceforth simply as revenues), on the other hand, should be defined to account for the above limitations. In this context, price is represented by the average amount allowed for each service; utilization applies only to the usage of services from covered benefit areas; and population refers to Medicare beneficiaries or private Blue Shield subscribers. Since claims paid under these programs constitute the data base for this study, estimation of the total expenditures factors also must be limited to services and persons covered by each respective program. Thus, the price variable remains the sole indicator of difference between expenditures and revenues. The two price variables also are of interest in explaining total revenues. While average allowances enter directly into determining

revenue, average billed charges affect revenue indirectly, since they are used to calculate prevailing fee screens which in turn determine the amounts allowed.

Whereas the price and population components of the model can be estimated explicitly in terms of average billed charges, average allowances, and persons at risk, the second term, utilization, must be inferred implicitly. The product of the second and third terms, utilization and population, represents the total quantity of services used. Quantity is indexed in the same manner as price from the claims data, and then population increases are discounted from the quantity index yielding utilization per person.

A. INDEX FORMULA

The selection of the index formula is dictated by the analytic purposes for which the index is to be used. As components in the above model, the price and quantity indices should incorporate appropriate weights which reflect the proportional contribution of each procedure to total revenues or expenditures. This suggests the use of a weighted aggregative index. The problem then becomes one of deciding on a system of weights. The base weighted or Laspeyres index, which is the type used in the CPI (Consumer Price Index) has the advantage of stability. Since the weights remain constant over time, one is guaranteed that only price changes will affect the index. However, there is evidence that the Laspeyres index may overestimate the true amount of change by failing to recognize and account for shifts in usage to cheaper substitionary services. The Paasche index, which employees a different set of weights from each current time period, overcompensates for these problems, and thus may underestimate price changes and falsely represent

the effects of weight changes as price movement. Given the effects of changes in medical technology in the past decade, it has been decided that a dynamic model is needed which also will provide stable results. Thus the ideal (Fisher's) index, which is the geometric mean of the Laspeyres and Paasche indices, presents itself as a suitable compromise. Fisher's ideal index lends itself to both price and quantity applications, and it will allow the multiplication of both to produce indices of total expenditures and revenues.

The mathematical representation of the indices and their variances is presented in Appendix A.

B. SAMPLE STRATIFICATION

A desirable attribute of sample structure is the aggregation of similar and related sampling units (i.e., procedure codes) into homogeneous groups or strata. Certain key factors appear to affect strongly the price and quantity patterns. Two of the most dominant and obvious factors are state (location) and line of business. The procedure coding systems that define the classification of services and index sampling units vary widely across Blue Shield Plans, and within Plans there are significant differences between the coding of Medicare and private business claims. Within each Plan's private business there is a further distinction between two major lines of business -- UCR and fee schedule or indemnity programs. UCR programs pay claims according to current reasonability screens analagous to Medicare's prevailing fees, but fee schedule programs restrict allowances to a fixed schedule of maximums which may or may not be adjusted to reflect current fee levels. Differences in average allowances and quantities between the two types of coverage also are interesting subjects for analysis relative to cost containment policy.

Geographic region, physician specialty, and generic type of service are the remaining factors of major importance. They are defined specifically for each Plan/state in Appendices B, C, and D, and constitute the parameters for stratification of the index samples.

C. PROPORTIONAL WEIGHTING OF STRATA

The nature of procedure classification is such that some types of service require a much greater number of procedure codes than others. For instance, most classification systems contain thousands of surgical and radiology codes, compared to only a few dozen codes for obstetrical and medical services. Consequently, the claims data for surgical and radiology services tend to be dispersed thinly over many codes. A relatively small number of such codes can attain adequate volumes for index sampling. Therefore, although a substantial number of procedures may be sampled, they tend to represent a disproportionately small percentage of total services for these types of service. For this reason, surgery and radiology services appear to be under-weighted in the CPI-Physicians' Fee component in proportion to medical and obstetrical services. To compensate for this problem, the weights of indices for each sampling stratum (which is defined by type of service as well as region, specialty, and Plan/line of business) are made proportional to the stratum's share of total expenditures or revenues, depending on the type of index involved.

D. DEFINITION OF SAMPLING UNITS

An essential property of sampling units is that they be accurately and consistently defined. The itemization of prices must be sufficiently specific so that changes in price levels reflect real economic phenomena rather than variability or uncertainty in definition of what is being measured. To achieve this final level of definition, the claims data are classified according to the procedure performed, as defined by each Plan's respective procedure terminology coding system. Again, due to the uniqueness of each Plan's terminology system, there are very few procedures with definitions that are common among all Plans and for which all Plans also reflect substantial sampling volumes. This problem was addressed in the first annual report on this project (Aug.15,1979), in which it was demonstrated that it would be possible to sample only a limited number of procedures, if a common sample were required across all Plans. Therefore, the procedure samples are defined individually for each Plan. Cross-sectional comparisons among Plans are to be based on index values with respect to price changes and on a subset of procedures that are common to all Plan samples for direct price and quantity analyses.

E. SELECTION OF SAMPLE

The sample of procedures for each Plan/line of business is chosen selectively rather than randomly, due to the restrictive criteria that limit the number of qualified procedures. The vast majority of procedures in each state either are too broadly defined in practical use to ensure consistent price data or they do not represent sufficient data on a regular basis for

sampling. A list has been developed for each state of those procedures which are sufficiently well-defined for inclusion in the sample. The sample of procedures in any quarter is a subset of this list, consisting of those procedures which occur with a minimum frequency of ten services in the respective sampling strata. This flexibility in the sampling frame is necessary to obtain a broad sample of procedures, due to the high degree of stratification and the associated probability that even frequently reported procedures will not occur in sufficient volume for sampling in every stratum and quarter. The effect of this policy is to include most eligible procedures in the sample each quarter for the dominant strata, while samples in lower volume strata are more variable and subject to some random index fluctuations. Variances of the indices can be examined to identify and exclude from analysis indices which, as the result of sample variations, are too erratic to be reliable.

III. DATA BASE ORGANIZATION

The price and quantity indices computed according to the methodology presented in the preceding section are based on data derived from Medicare and private business claims paid by four Blue Shield Plans in five states. This section describes the procedures used to extract the appropriate information from the claims files and to organize and prepare the data for index calculation.

A. DATA COLLECTION

Every service reported by a physician for which Blue Shield or Medicare has made payment is recorded on computer data files. Among the many types of information recorded for each claim are several key data items referenced by the index system. Identification of the reporting physician and the nature of the procedure performed provide the classification of data according to geographic region, physician specialty, and type of service for sample stratification and procedure code for identification of the specific sampling unit. The date on which the service was performed is used to identify data as pertaining to the base year or other period. After all the data relevant to a particular period, stratum, and sampling unit have been identified, the price and weighting statistics are computed. Total billed charges and total allowances are accumulated from the relevant claims for weighting the price and quantity indices, and the average charges and average payments to be indexed are computed by dividing the total dollars by total number of treatments (services) reported.

In addition to the above information, claims data are further classified

by the Blue Shield Plan and type of program under which the subscriber is covered -- Medicare, private Blue Shield UCR, or private fee schedule business. In order to maintain the sensitivity of the index system to the distinct trends in each program, the collection and indexing of data from each of these three programs are conducted independently. However, the indices thus computed also can be aggregated across the two private lines of business to produce consolidated private business indices for each state.

B. INDEX TIME PERIODS

In this study the base period is the calendar year 1978. Prices and quantities for this year mark a reference index level of 100.0, against which other periods are compared, and they provide the base weights in all index calculations. The year 1978 was chosen as the base period for two main reasons. It represents a sufficiently recent period that the associated weights should continue to be representative of usage patterns into the early 1980's as well as for previous years, and it appears to be a relatively stable period with respect to price inflation and utilization, which makes it a suitable reference point for economic analysis.

Data to be indexed against the base are aggregated quarterly. Monthly files generally do not contain sufficient volumes of data to generate reliable index results at a highly stratified level. Generating indices quarterly should ensure adequate sampling volumes for most major strata, and the quarterly cycle represents a manageable basis for collecting and processing data files from the participating Blue Shield Plans.

C. SELECTION OF INCURRED DATE BASIS

The classification of data into index base and current periods is based on the incurred date of service. Blue Shield and Medicare claims normally are maintained by date of claim payment for administrative purposes. The reason for choosing incurred date instead of date of claim payment as an index basis is its logical connection with the way in which it is believed doctors determine their charges. It would appear that a doctor's charge for any given procedure should be related more to the date on which the service was performed (i.e., the incurred date) than to the date on which Blue Shield pays the claim. Allowances, on the other hand, are determined by both the amount charged and by Blue Shield or Medicare payment policies, and it is not evident that either date is a superior basis for the average allowance price index. Consequently, for reasons of economy, consistency, and convenience of interpretation, and since the primary focus of this study is on physicians' billed charge prices, charge and allowance indices both are computed on an incurred date basis.

Incurred date indices, unfortunately, have an intrinsic problem arising from the time lag in reporting of claims by doctors. It is virtually impossible to collect all of the claims incurred in a given quarter and still produce an index for that period in timely fashion. Studies have shown, however, that about ninety-five percent to ninety-nine percent of the claims incurred in a quarter are paid by the end of the following two quarters, and the collection of data on this basis provides a good combination of adequate data coverage and reasonably timely reporting of index results.

D. DETERMINATION OF SAMPLING STRATA

The purpose of stratification in the PBS index is to partition the data into homogeneous groups, each of which represents a sufficient volume of data to permit the calculation of meaningful indices. The three levels of stratification -- geographic region, physician specialty, and type of service -- are defined around this goal.

The most widely accepted classification of economically related geographic regions is the Standard Metropolitan Statistical Area (SMSA), as defined by the U. S. Bureau of the Census. To the extent possible, the index regions have been defined to conform to these areas. In some cases, however, it has been necessary to aggregate data into larger regions to achieve adequate sampling levels. Each state also has an "all other" region, which includes all areas with insufficient data to support separate regional strata. The regional strata for each state are defined in Appendix B. Although regions are defined in terms of counties, there are insufficient data to permit generation of reliable indices for most individual counties. Therefore, indices are aggregated geographically only at the levels of regional strata and state.

Classification by physician specialty is based on the thirty major specialties listed in Appendix C; and the types of service defining the final level of stratification are displayed in Appendix D. Specialties and types of service representing non-physician services and commodities have been deleted from the study. Although several of these categories reflect low volumes of data for various states, they do not lend themselves to combinations of the type performed on geographic areas. Instead, the individual category identities are maintained throughout the indexing process regardless of data

volume, and those failing to achieve adequate sampling levels do not enter into the indices for the respective state and region.

A small percentage of claims data do not conform to the above stratification categories. These include claims paid to doctors practicing outside of, but treating patients from, the five participating states, and claims with invalid information or with rarely used specialty and/or type of service codes. Such data are extraneous to the objectives of the index, and are edited out of the index data base as a quality control measure.

IV. OUTPUT REPORTS

The system that has been developed to process and analyze claims data will generate index reports on a quarterly basis for each year of data collected from the participating Blue Shield Plans. The data base for most Plans extends retrospectively to 1974, and is scheduled to be collected through June, 1983. Index reports are generated for each Plan whenever sufficient data have been collected to accumulate the data base of services incurred in a quarter (as discussed in the previous section on incurred date selection).

The reports generated by the system of computerized index programs include statistics on data volumes in the universe and sample for each state and sampling stratum, as well as the price and quantity indices and index variances, discussed in the section on Index Formulas. The universe and sampling statistics include total volumes of line items (computer claim records), services (number of treatments for each line item), billed charges and amounts allowed. These statistics are useful in analyses for assessing the reliability of index results and relating the price and quantity indices to trends in total expenditures and revenues.

Cross-sectional comparisons of price indices and average prices can be made, based on individual quarterly reports. However, several other types of analysis will require additional programs and data processing. Longitudinal analysis of trends in the numerous states, lines of business, and strata will be accomplished by concatenating report statistics for the periods of interest. Quantity indices may be expected to reflect a high degree of seasonality, particularly for elective procedures which often are scheduled around vacation and holiday seasons. Therefore, these results should be

smoothed by the use of moving four-quarter averages or other methods.

In addition to indices and statistical summaries, computer generated graphical displays are available to facilitate the identification of trends in the indices and various expenditure and revenue factors. Given the specification of index and sampling statistics, there exists the flexibility to modify and supplement the above outputs with such reports and displays as may be deemed necessary.

INDEX FORMULAS

Mathematically, the index formulas are represented as follows.

For each sampling unit in a stratum (i.e., procedure code), let:

P_0 = price (average billed charge or average allowance in the base period over all services included in the sampling unit);

P_t = price in the current period;

Q_0 = base period quantity (number of services included in the sampling unit;

Q_t = current period quantity.

Then, the price and quantity indexes are:

$$PI \text{ (Price Index)} = 100 \times \sqrt{\{\Sigma(P_tQ_0)/\Sigma(P_0Q_0)\} \times \{\Sigma(P_tQ_t)/\Sigma(P_0Q_t)\}}$$

$$QI \text{ (Quantity Index)} = 100 \times \sqrt{\{\Sigma(Q_tP_0)/\Sigma(Q_0P_0)\} \times \{\Sigma(Q_tP_t)/\Sigma(Q_0P_t)\}}$$

Further, $(PI \times QI)/100 = 100 \times \Sigma(P_tQ_t) / \Sigma(P_0Q_0) =$ the cost index (i.e., index of total expenditures or revenues)

Alternatively, for convenience in subsequent expansions, the indices can be expressed in terms of their Laspeyres and Paasche components:

$$LPI \text{ (Laspeyres Price Index)} = 100 \times \Sigma(P_tQ_0) / \Sigma(P_0Q_0)$$

$$LQI \text{ (Laspeyres Quantity Index)} = 100 \times \Sigma(Q_tP_0) / \Sigma(Q_0P_0)$$

$$PPI \text{ (Paasche Price Index)} = 100 \times \Sigma(P_tQ_t) / \Sigma(P_0Q_t)$$

$$PQI \text{ (Paasche Quantity Index)} = 100 \times \Sigma(Q_tP_t) / \Sigma(Q_0P_t)$$

$$FPI \text{ (Fisher's Price Index)} = \sqrt{LPI \times PPI}$$

$$FQI \text{ (Fisher's Quantity Index)} = \sqrt{LQI \times PQI}$$

Indices for aggregations of strata (e.g., over all specialties and types of service in a given region, or over all strata for an overall state/line of business) are obtained by weighting each of the above terms with weights, W, that are proportional to each stratum's share of total expenditures or revenues in the aggregation.

Define W, such that $\Sigma W_0 = \Sigma W_t = 1$. Then,

Aggregated LPI = $\Sigma(W_0 \times LPI)$

Aggregated LQI = $\Sigma(W_0 \times LQI)$

Aggregated PPI = $\Sigma(W_t \times PPI)$

Aggregated PQI = $\Sigma(W_t \times PQI)$

Aggregated FPI = $\sqrt{\text{Agg LPI X Agg PPI}}$

Aggregated FQI = $\sqrt{\text{Agg LQI X Agg PQI}}$

The indices also can be expressed as weighted aggregates of price relatives for the purpose of defining price index variances.

Let $I = 100X (P_t / P_0)$ (the price relative index for a sampling unit).

To aggregate the price relativities in a stratum, define weights f and g, such that:

$f = P_0Q_0$ (base period expenditures or revenues);

$g = P_0Q_t$ (current period quantities at base prices).

Then, $LPI = \Sigma(f \times I) / \Sigma f$

$PPI = \Sigma(g \times I) / \Sigma g$

Define price variances, Var P_t and Var P_0, as the variance of average prices for a sampling unit. Then, the variance of the sampling unit index,

$$\text{Var } I = I^2 (\text{Var}P_t / P_t^2 + \text{Var}P_0/P_0^2);$$

and the variances of indices aggregated over strata are computed as follows:

$$\text{Var LPI} = \Sigma(W_0^2 \times \text{Var I})/\Sigma(W_0^2);$$

$$\text{Var PPI} = \Sigma(W_t^2 \times \text{Var I})/\Sigma(W_t^2)$$

The covariance of the Laspeyres and Paasche indices are:

$$\text{Cov (LPI, PPI)} = \Sigma(W_0 \times W_t \times \text{Var I})$$

and

$$\text{Var FPI} = (\tfrac{1}{2}\text{PPI}/\text{FPI})^2 \text{ Var LPI} + (\tfrac{1}{2}\text{LPI}/\text{FPI})^2 \text{ Var PPI} \div \tfrac{1}{2} \text{ Cov (LPI, PPI)}$$

based on the Taylor expansion.

Comparable variances are not defined for the quantity indices, since the inverse concept (variance of services among prices) has no practical interpretation.

GEOGRAPHIC INDEX REGIONS

State	Index Region	Component Counties
I. Vermont	A. Burlington Area	1. Chittenden 2. Washington
	B. Southern Metropolitan	1. Rutland 2. Windsor 3. Windham
	C. All Others	-------
II. New Hampshire	A. Manchester-Nashua Area	1. Hillsborough
	B. All Others	-------
III. South Carolina	A. Charleston - North Charleston Area	1. Berkeley 2. Dorchester 3. Charleston
	B. Greenville-Spartanburg-Anderson Area	1. Greenville 2. Spartanburg 3. Anderson
	C. Columbia	1. Aiken 2. Lekington 3. Richland
	D. All Others	-------
IV. Pennsylvania	A. Greater Pittsburgh	1. Beaver 2. Washington 3. Allegheny 4. Westmoreland
	B. Greater Philadelphia	1. Philadelphia 2. Montgomery 3. Chester 4. Delaware 5. Bucks
	C. Central	1. Dauphin 2. Cumberland 3. Adams 4. Perry 5. Lancaster

State	Index Region	Component Counties
IV. Pennsylvania	D. Eastern	1. Susquehanna 2. Lackawanna 3. Luzerne 4. Monroe 5. Carbon 6. Lehigh 7. Northampton
	E. All Others	-------
V. Colorado	A. Denver-Boulder Area	1. Adams 2. Arapahoe 3. Boulder 4. Jefferson 5. Douglas
	B. Colorado Springs-Pueblo Area	1. Teller 2. El Paso 3. Pueblo
	C. Fort Collins Grelley Area	1. Larimer 2. Weld
	D. All Others	-------

MAJOR INDEX SPECIALTIES

General Surgery
Neurological Surgery
Orthopedic Surgery
Plastic Surgery
Thoracic Surgery
Obstetrics-Gynecology
Ophthalmology
Otorhinolaryngology
Colon and Rectal Surgery
Urology
Internal Medicine
Cardiology
Gastroenterology
Pediatrics
Neurology
Psychiatry-Neurology
Anesthesiology
Dermatology
Radiology
General Practice
Family Practice
Pathology
Allergy and Immunology
Podiatry
Dental Surgery
Chiropractics
Nephrology
Pulmonary Diseases
Nuclear Medicine
Physical Medicines & Rehabilitation

MAJOR INDEX TYPES OF SERVICE

1. Assistant Surgery
2. Surgery
3. Obstetrical Care
4. Anesthesia
5. Radiology
6. Medical Care
7. Psychiatric Care
8. Pathology and Diagnostic Medical Services
9. Consultations

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